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Drift Predictions of Three Herbicide Tank Mixes

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Pesticide Precautionary Statement

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

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ABSTRACT

This report illustrates the utility of the FSCBG forest spray model as a tool to predict downwind drift of herbicide sprays. For a given set of conditions - weather, aircraft release height, drop size, and application rate the model predicts downwind deposition of the herbicide. For this demonstration we predicted the downwind deposition of 3 different herbicide tankmixes, each applied under the same set of conditions. Downwind deposition differed among the three tankmixes due to differences in the tankmixes. The model predicted less downwind deposition from drift of the water base tankmix than of the oil base tankmix.

INTRODUCTION

In recent years there has been a convergence of several factors which has set the course toward improving the efficiency and safety of pesticide application. Representatives of government, industry, and academia have focused on these needs in recent years. Each has applied their experience, knowledge, and tools to improve the application of pesticides. Advancement in atomization technology, development of adjuvants, carriers, and low volatile tankmixes; and an awareness of how atmospheric conditions influenced deposition and drift have emerged over the past few years.

A promising advancement for planning and conducting aerial spray operations is mathematical modeling. Models have become a way of life in our quest to predict future events with knowledge from the past. There has been a developing interest in spray modeling over the past 5 years by scientists and engineers who are involved with pesticide activities.

Aerial application of pesticides is one method used by forest managers to manage forest defoliators, competing vegetation, and noxious weeds. Although the use of pesticides in forestry is minor compared to agriculture, the multiple use of forest lands has focused public attention on forest management, including use of pesticides. As part of an extensive program to develop and evaluate efficient and safe pest management systems, the USDA Forest Service (FS) has supported research on the behavior of aerially applied pesticides. This has included the behavior of spray from the time it is released from the aircraft until it has been deposited, or in the case of spray drift, dissipated to levels that are environmentally insignificant. Because mathematical spray dispersion models are useful in determining interactions of the many factors affecting spray behavior, the FS has supported the application and development of modeling over the last decade (Barry and Ekblad 1983). Models are now available for several aspects of aerial application; however, this paper is limited to the Forest Service Cramer/Barry/Grim (FSCBG) forest spray model.

FSCBG MODEL DESCRIPTION

The FSCBG model predicts spray concentrations, dosages, and deposition above and within the coniferous forest canopy and on the forest floor. It uses several codes (Figure 1) to predict behavior of spray. The 32K word program is adaptable to other computer systems; currently it is a FORTRAN IV program used on the USDA UNIVAC 1108 computer at Ft. Collins, CO. and on the University of California, Davis campus VAX computer. The user may select any code or combination of codes. The Above Canopy and Below Canopy Evaporation code option allows the user to specify drop evaporation in calculations of concentration, dosage and deposition. If the user selects the drop evaporation option, the program auatomatically calculates change in drop diameter with time, using a polynomial expression fitted either to empirical data or theoretical calculation. The Wake-Settling Velocity code permits the user to input the aircraft wake-settling velocity directly or to input the aircraft weight, wing span and ground speed. The Canopy Penetration code

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permits the user to calculate the fraction of material presented to the forest canopy top, and to simulate penetration of the spray into the canopy and to the ground. The Dosage and Concentration Dispersion codes permit the user to calculate dosage, concentration and area coverage of user specified dosage and concentration levels above the canopy and below the height of elevated inversions. The Deposition Dispersion code allows the user to calculate deposition and deposition area-coverage at any height below the height of elevated temperature inversions, including heights below the canopy top when the model is used in conjunction with the Canopy Penetration code. The program can provide up to 737 receptor coordinates for making downwind calculations and for drawing isopleths of dosage, concentration, or deposition (Dumbauld et al. 1980).

PROCEDURES

This report demonstrates the capabilities and utility of the FSCBG forest spray model (Dumbauld et al. 1980) to the land manager. By studying predictions of downwind herbicide drift deposition from a spray area, the land manager can best decide which tankmixes and operational conditions would be favored environmentally. In this demonstration the only changing variable was the tankmix. Three different tankmixes of Kuron[1/] were applied by a Bell 47-G helicopter (Table I) with D8-46 nozzles. The treatment area, consisting of grasses and low brush, was in the Southwest. The helicopter was flown at a height of 23 meters (75 feet) above ground and speed of 20 meters/sec (45 miles/hr) with an assumed swath width of 15 meters (50 feet) (Table II). The treatment area was approximately 750 meters wide by 1,810 meters long with the wind blowing perpendicular to the 1,810 meter length.

The three tankmix options (Table III) considered by the proposed land manager were as follows: Tankmix I consisting of 0.5 gal. Kuron + 7.5 gal. water; Tankmix II consisting of 0.5 gal. Kuron + 1 gal. diesel; and Tankmix III consisting of 0.5 gal. Kuron + 4.5 gal. diesel. The land manager's desire was to ascertain which tankmix would offer the least drift on the downwind side of the treatment area.

The evaporation component of the FSCBG model was engaged to evaporate the water portion of the tankmix. The Kuron and diesel were assumed to be nonevaporative. The initial drop-size distribution (Table IV) for D8-46 spraying systems nozzles was determined by wind tunnel tests at University of California, Davis, CA (Yates and Cowden 1985).

The meteorological parameters are given in Table V.

The deposition isopleths (Figures 1, 2, 3) and the centerline deposition X, Y plot (Figure 4) were output on the Tektronix 4107 color graphics terminal/4695 color graphics copier system at Forest Service, Forest Pest

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1/ Kuron, a registered trade name, was discontinued by Dow Chemical in 1984. Its common name is Silvex and its chemical name is 2-(2,4,5,-Trichlorophenoxy) propionic acid.

Management, Davis, CA. The graphics software program utilized was SAS/Graph contained on the University of California Davis VAX computer system. The FSCBG has an option to output data to a disc file which can be utilized by graphics software packages as SAS/Graph to produce desired graphic displays.

To produce deposition isopleths, it is necessary to set up an even-spaced downwind grid of prediction points for the output disc file. In this exercise the points were selected at every 5 meters on the X-axis and every 50 meters on the Y-axis for Tankmix I and every 50 meters on the X-axis and every 100 meters on the Y-axis for Tankmixes II and III. The X-axis scale was changed to 5 meters for ease of formating. SAS/Graph can then utilize these values and interpolate the desired values of downwind deposition for the isopleths. The higher the resolution of the predictive grid, the higher the validity of the isopleths. To produce a centerline deposition X, Y plot, it was necessary to set up a line of discrete receptors running downwind perpendicular at the center of the spray area. Data for each plotted line (Figure 4) were acquired by a separate run of the FSCBG then combined through local editing procedures into one disc file for SAS/Graph to utilize in the plot.

Figures 1, 2, 3 for Tankmixes I, II, III, respectively, show isopleth lines enclosing predicted deposition of the nonevaporative portion of the spray equal to or greater than the isopleth level. The first level (50 oz/acre) is closest to the treatment area. The last level (0.05 oz/ac) is the furthest from the treatment area. Note for Tankmix I (Figure 1), the first level (50 oz/acre) is within the treatment area and, therefore, is off the bottom of the graph. The first isopleth level showing is 20 oz/ac.

RESULTS

By comparing the three isopleth Figures 1, 2, and 3 and Figure 4 it becomes readily apparent that Tankmix I offers the least drift downwind of the treatment area. Tankmix III shows the greatest amount of drift and thus would be the worst case. The model, therefore, predicts less downwind deposition for water base sprays compared to oil base sprays.

Tankmix I contained a water carrier which under the conditions of this exercise, would be favored over an oil carrier. Drops from Tankmix I with their higher densities deposited rapidly. Those too small to deposit near the treatment area were reduced in size and an unknown number were vaporized under the low relative humidity of 30%. Drops from Tankmix III, with oil used as a carrier, tended to remain airborne and travel downwind. This phenomena demonstrates that under certain conditions evaporation can aid in reducing downwind deposition of herbicide drops due to drift. Drops which move beyond treatment areas are reduced in size or they are volatized and thus are dispersed widely in the atmosphere. Their contribution to atmospheric pollution would, under most conditions, be insignificant.

By exercising the FSCBG model land managers can obtain additional information for decision making. He can select the weather conditions, aircraft release parameters, herbicide drop size, application rate, and tankmix which will best accomodate his treatment objectives. Even in wildlands, remote from inhabitations, all available tools should be used to promote the efficiency, efficacy, and safety of herbicide application.

TABLE I

AIRCRAFT INPUT PARAMETERS FOR BELL 47-G HELICOPTER

Rotor diameter (WNGSPN)	9.5 meters
Aircraft weight (ARCRWT)	1000 kilograms
Aircraft speed (ARCRSP)	20 meters/sec

TABLE II

SPRAYING LOGISTICS PARAMETERS

Number of swaths (NSOURC)	50
Width of each swath (SWATH)	15 meters
Release height (HGTCFT)	23 meters

TABLE III

TANKMIX INPUT PARAMETERS

Tankmix I -	
a) Density (DENLIQ)	1.00 g/cm
b) Fraction volatile (DRPPCT)	0.94
c) Emission rate (Q)	8 gal/ac
Tankmix II -	
a) Density	0.95 g/cm
b) Fraction volatile	0.70
c) Emission rate	5 gal/ac
Tankmix III -	
a) Density	0.85
b) Fraction volatile	0.00
c) Emission rate	5 gal/ac

TABLE IV

DROP-SIZE DISTRIBUTION

Drop-Size Category	Upper Drop Diameter (μm) (DRPUPR)	Fraction of Total Mass in Category (PCTMAT)
1	908	.015
2	842	.036
3	776	.058
4	710	.048
5	644	.096
6	578	.079
7	512	.099
8	447	.106
9	382	.103
10	318	.118
11	252	.095
12	187	.083
13	122	.052
14	56	.012

TABLE V

METEOROLOGICAL INPUT PARAMETERS

Air pressure (AIRPRS)	865 mb
Air temperature (AIRTPO)	21° C
Wind speed (WSOCAN)	4.5 meters/sec
Relative humidity (RELHMO)	30%
Wind direction (THETA)	180°
Standard deviation of wind azimuth angle (SIGAP)	16°
Standard deviation of wind elevation angle (SIGEP)	6°

ACKNOWLEDGEMENTS

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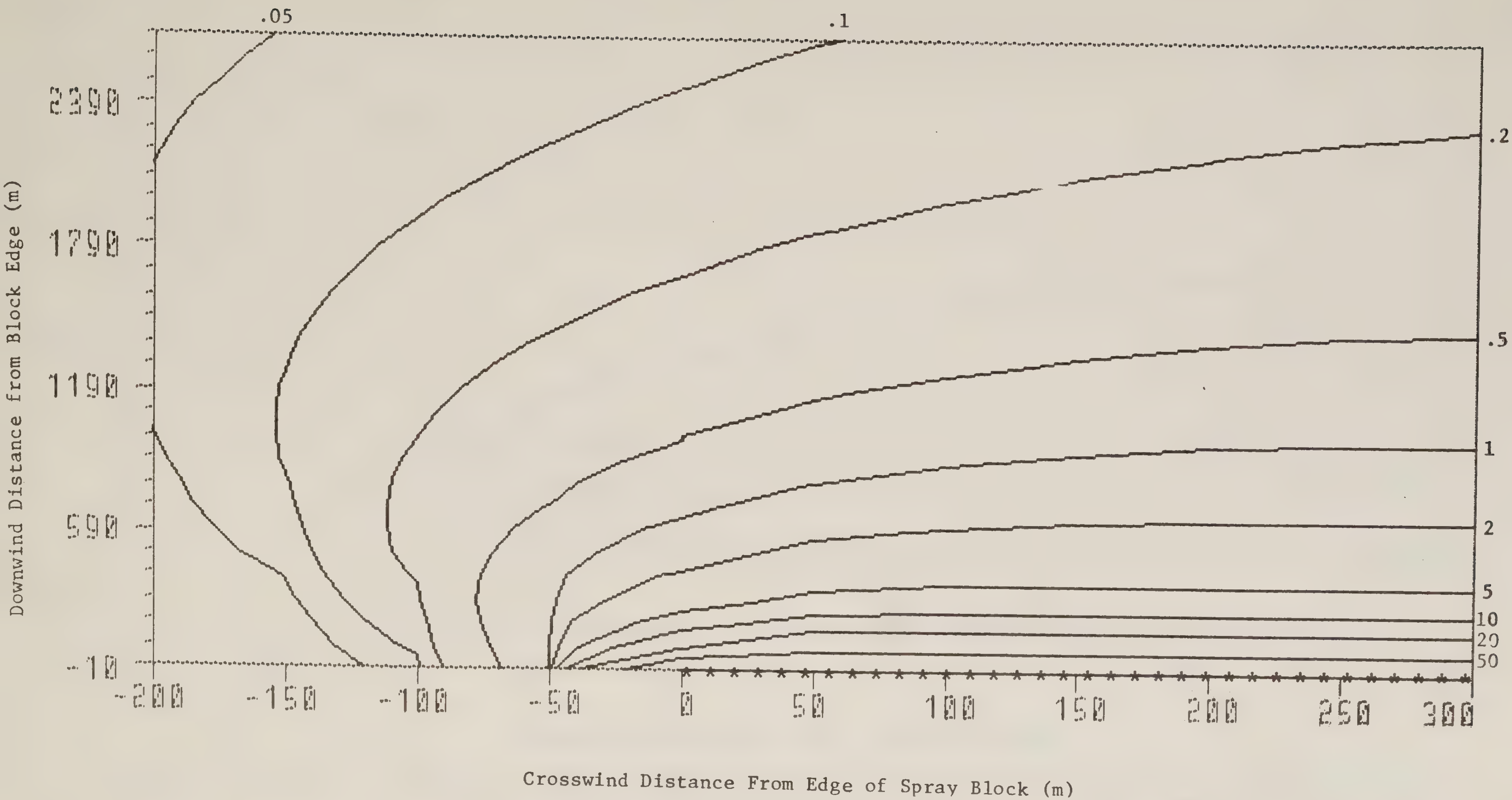


Figure 2 - Tankmix II Deposition isopleths in ounces per acre, release height 23 meters, wind speed 4.5 meters per second, wind direction perpendicular to edge of spray block, temperature 21 °C, and relative humidity 30%. * * * * line is downwind edge of treatment area.

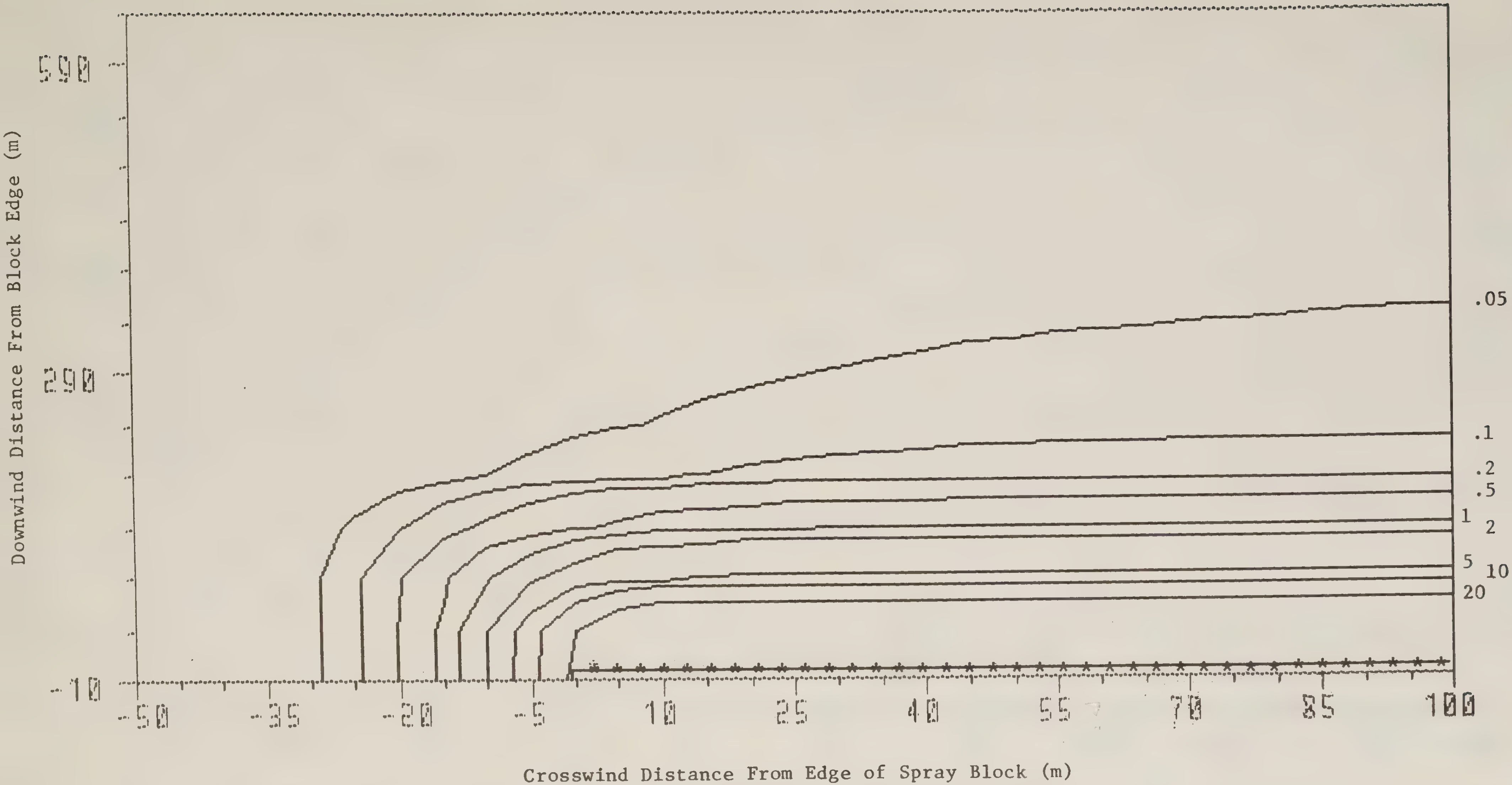


Figure 1 - Tankmix I Deposition isopleths in ounces per acre, release height 23 meters, wind speed 4.5 meters per second, wind direction perpendicular to edge of spray block, temperature 21°C, and relative humidity 30%. * * * * line is downwind edge of treatment area.

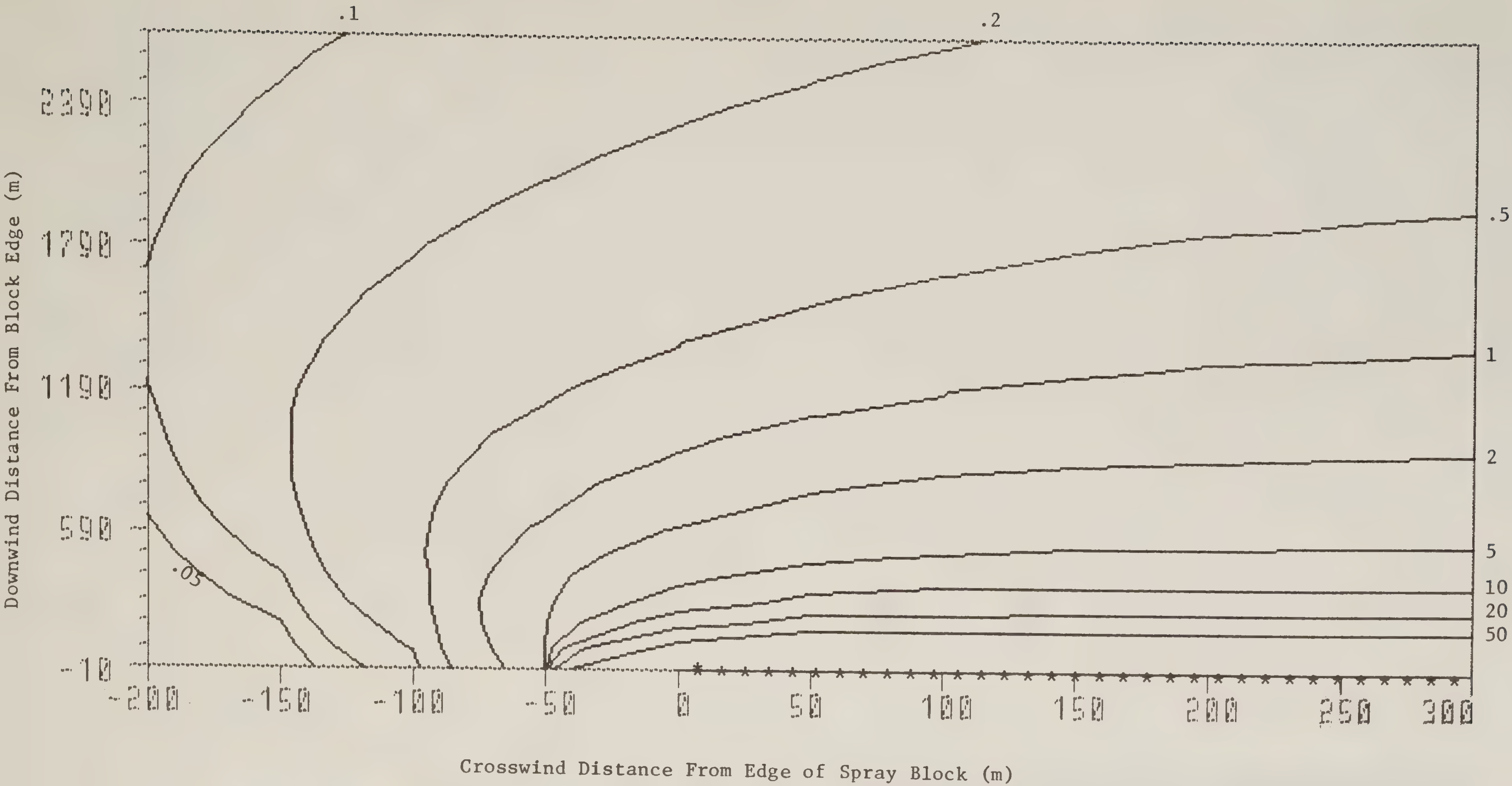
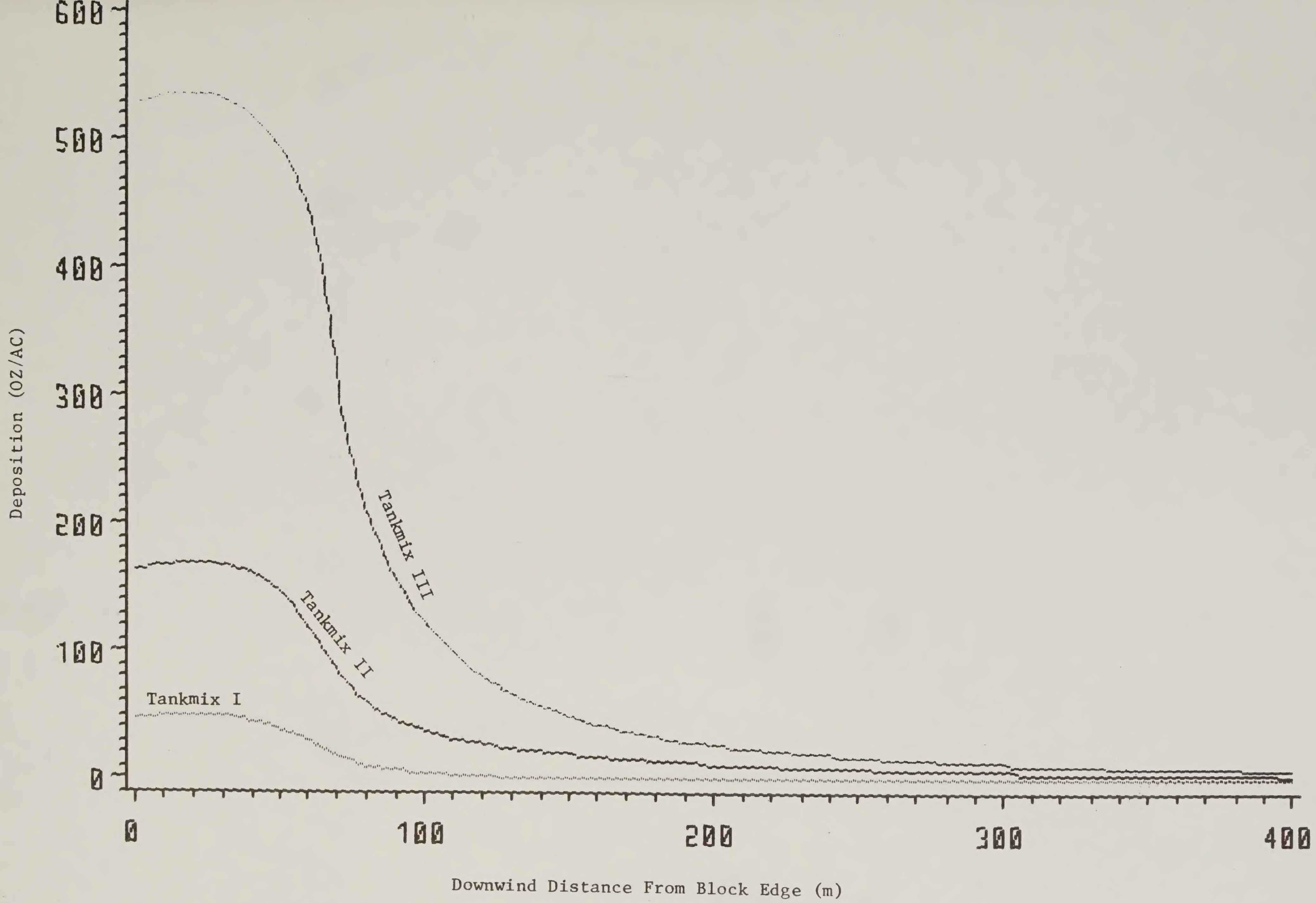


Figure 3 - Tankmix III — Deposition isopleths in ounces per acre, release height 23 meters, wind speed 4.5 meters per second, wind direction perpendicular to edge of spray block, temperature 21 °C, and relative humidity 30%. * * * * line is downwind edge of treatment area.



<u>Figure 4</u> - Centerline downwind deposition from edge of spray block for each tankmix.

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